Research in Physical Education, Sport and Health
2020, Vol. 9, No. 2, pp.51-56
ISSN(Print):1857-8152; ISSN(Online):1857-8160

COMPARISON OF CARDIO-PHYSIOLOGICAL AND ANTHROPOMETRICAL PARAMETERS BETWEEN BASKETBALL AND FOOTBALL PLAYERS

DOI: https://doi.org/10.46733/PESH20920051pg
(Original scientific paper)

Jasmina Pluncevic Gligoroska [1], Jan Marosevic-Markovski, Marko Todorovski, Tanja Lekovska Stoicova [2], Sanja Manchevska[1]
[1] Institute of Physiology, Faculty of Medicine, UKIM, Skopje, R. Macedonia
[2] Institute of Public health, Faculty of Medicine, UKIM, Skopje, R. Macedonia

Abstract
Approach: Anthropometrical and physiological parameters in different teams' sports are mainly due to the physical, biomechanical and technical requirements of the sport games. Purpose of this study was to compare the anthropometric and physiological features of soccer and basketball players in Republic of Macedonia. Material and methods: In this study were enrolled two hundred and twenty (220) athletes, basketball (BBP) and football players (FBP), divided in two equal groups (N=110), age span from 18 to 30 years old, mean age for BBP=20.94 ±3.32 and SCP= 24.37± 4.36 years. Body composition was estimated with Matiegka method, and muscle, bone and fat mass were obtained. All athletes underwent ergometry testing by Bruce protocol. Results: The relative body components were as follows: muscle mass percent was statistically higher in basketball players (BBP=54.28 ±3.72%; FBP=53.17 ± 4.9); body fat percent was statistically higher in football players (BBP=13.92 ± 3.97%; FBP=14.75 ± 1.3) ; bone mass % was same in both groups (BBP=17.56 ± 1.48%; FBP=17.37 ± 1.17). The duration of test (BBP=13.11 ± 2.17 min; FBP=13.43 ± 2.3 minutes) and maximal oxygen consumption (BBP=47.23±5.32; FBP= 47.35 ± 5.61 ml/kg/min) showed similar mean values for both sports. Conclusions: The comparison of anthropometric variables showed higher values for height, weight and muscle component in basketball players, while body fat percent was higher in football players. The heart rate's curve during Bruce protocol showed better cardiovascular adaptation in football players, although maximal oxygen consumption was not significantly different.

Key words: *basketball, football, body composition, ergometry*

Introduction

The main classification of sports is regarding the metabolic way of energy expenditure during the activity. Sports can be classified into two broad types: aerobic and anaerobic. The soccer and the basketball games are classified as hybrid sports, dynamic and intermittent by nature. Fast and short movements, changes in speed and direction are different in these sports, and specific physical and technical requirements demand specific physiological and physical conditioning (Mancha-Triguero et al., 2020).

Athletes engaged in various sports activities differs in physical and physiological charactesristics (Gusic et al., 2017). The ratio of dynamic and static muscle contractions during basketball and soccer training and game is different, and in different way could influence on the anthropometric and physiologic parameters of athletes (Boone J et al., 2014; Alemdaroglu et al., 2014). The dimensions of sport area, number of players in the team, the demanding of the games lead to different level of physical activities during the basketball and soccer game. Sports scientists are not unanimous regarding the ratio of aerobic and anaerobic activities in these sports. In the basketball most of the physical work is performed at a high intensity and certain level of endurance is important to meet game demands (Ransone J , 2016). Analyses of physiological requirements of modern basketball game showed a major reliance on the anaerobic metabolism across positions, with secondary reliance on the aerobic energy system (Hoffman, J.R., 2003). The basketball is considered as an intermittent high-intensity sport that requires mainly anaerobic metabolism (Castagna et al., 2009; Popovic S., et al, 2013).The average intensity of basketball game is above 85% of maximal heart rate and above of maximal oxygen consumption (Balciunnas et al., 2006).

In the soccer the training is usually based on series of moderate activities followed by alternating periods of high intensity movements (Masanovic et al., 2018). The aerobic energy contributes on average 90% of the total energy required during the game, with soccer players having an average oxygen uptake of 75-80% of maximal oxygen consumption and basketball players with 67% of maximal oxygen consumption (Krustrup et al, 2005; (Narazaki et al., 2009). Football is characterized by numerouse and various dynamic kinesiological activities, characterized as cyclical and acyclical movements (Corluka et al., 2018).

The analysis of body composition mainly refferes to the amount of lean muscle mass and subcutaneouse body fat. Different compositions may predict success in different sports (Ransone J , 2016). Most elite basketball and soccer players tend to have body fat percent below lower range for sedentary people (Drinkwater et al., 2010). The body composition is important for elite soccer players, but that homogeneity between players at top professional clubs results in little variation between individuals especially regarding the players position (Sutton L. et al., 2009). The sports outcomes in team sports depends on multiple factors including players' energetic capacity, tactics and technique. The combination of these factors and theirs interactions generate a complex functional system which is modified during training specific physical activities (Sporis G. et al., 2014). Physiological, physical and technical requirements of basketball and soccer game are in thight feedback with physical fitness in athletes.

The aim of this study was to compare the anthropometric and physiological characteristics of soccer and basketball players in Republic of Macedonia.

Material and methods

In this study were enrolled two hundred and twenty (220) athletes, divided in two equal groups (N=110). Both groups, basketball players (BBP) and football players (FBP) were athletes from premier leagues in Republic of Macedonia. Athletes were at age span from 18 to 30 years old, mean age for BBP=20.94 ±3.32 and FBP= 24.37± 4.36 years. The testing were made at the Institute of Physiology and Anthropology, Faculty of Medicine, UKIM, Skopje.

Anthropometry

The Matiegka antripometric protocol was used to estimate the body composition. The longitudinal and circumferential dimensions were measured: height and weight, 6 skinfolds, 4 diameters and 5 circumferences. The final results of Matiegka protocol are three body components, muscul, bone and fat componenets expresse in absolute and relative maner: in kilos [absolute muscle mass (MMkg); absolute bone mass (BMkg) and absolute fat mass (FMkg)] and relative body components expressed in percent (MM%; BM%; FM%).

Ergometry testing

All subjects underwent standard treadmill exercise testing according to the Bruce protocol submaximal treadmill test in accordance with ACSM guidelines (Bozinovska et al., 2003). The exercise was finished when the subjects achieved the target heart rate (in beats per minute) defined as 85% of the age- and sex-predicted maximum heart rate. During the ergometric testing heart rates were registered at the end of each minute during the first ten minutes of exercise duration (ACSM, 2000).

Statistical Analysis

Continuous data are expressed as mean ± SD. Statistical significance was set for a 2-tailed p value < 0.05. The mean values of anthropometric characteristics and of cardiophysiological parameters of different groups of athletes have been compared by means of Students' 't' distribution test, and the level of significance <0.05. All analyses were adjusted for age and body mass index.

Results

The anthropometric parameters, including body mass components are shown in Table 1. The soccer players were older than basketball players. The basketball players were significantly higher and heavier than football players. The absolute values for all body components were higher in basketball players. The relative body components were as follows: muscle mass percent (MM%) was statistically higher in basketball players; body fat percent (BF%) was statistically higher in football players; bone mass (BM %) was same in both groups.

Table 1.: Anthropometric parameters for basketball and football players

	Basketball players			Football players			T test
	mean	SD		mean	SD		
Age (years)	20.94	3.32		24.37	4.36	17.8	<0.05*
Height (cm)	*191.15*	*7.52*	*3.9*	178.33	6.18	3.4	<0.05*
Weight (kg)	*86.13*	*12.31*	*14.2*	76.15	7.31	9.6	<0.05*
MM (Muscular mass in kg)	46.64	6.46	13.8	40.49	4.31	10.6	<0.05*
MM % (Muscular mass as %)	54.28	3.72	6.8	53.17	2.64	4.9	0.01*
BM (Bone mass in kg)	15.03	1.75	11.6	13.21	1.35	10.2	<0.05*
BM %(Bone mass as %)	17.56	1.48	8.4	17.37	1.17	6.7	0.27
BF (Body fat in kg)	14.10	6.09	43.2	11.27	1.77	15.6	<0.05*
BF% (Body fat as%)	13.92	3.97	28.5	14.75	1.32	8.9	0.04*
LBM (Lean body mass in kg)	72.21	8.93	12.3	64.87	5.88	9.1	<0.05*
BMI (Body mass index)	23.52	2.57	10.9	23.92	1.68	7.02	0.73

Table 2.: Cardio-physiological parameters for basketball and football players

	Basketball players			Football players			T test
	mean	SD	Coefficient of Var %	mean	SD	CoVariat %	P value
Hemoglobin (gr/dl)	13.65	1.63	11.94	14.08	1.13	8.03	0.027 *
Erythrocytes (10 ^{12}/dl)	5.35	0.61	101.92	4.76	0.39	8.12	0.250
Bruce protocol results							
HRRest (bpm^{-1})	73.9	8.75	11.84	69.28	10.10	15.87	0.05*
HR1	96.98	11.43	11.79	93.95	12.84	13.67	0.066
HR2	98.8	11.22	11.35	94.09	12.88	13.69	0.004*
HR3	100.35	12.55	12.5	95.11	13.22	13.90	0.003*
HR4	110.27	12.59	11.42	106.81	12.73	11.92	0.043
HR5	113.9	12.92	11.34	108.19	14.03	12.96	0.002*
HR6	116.26	12.58	10.82	109.53	14.54	13.28	0.0002*
HR7	127.18	13.32	10.47	122.3	14.80	12.10	0.01*
HR8	131.72	14.27	10.83	125.25	14.98	11.96	0.001*
HR9	131.93	22.41	16.98	128.50	15.85	12.33	0.19
HR10	136.63	34.51	25.25	134.58	27.44	20.39	0.63
HRRec	98	12.19	12.44	92.03	12.53	13.61	0.0004*
ET (minutes)	13.11	2.17	16.6	13.43	2.30	17.13	0.29
VO2max ml/kg/min	47.23	5.32	11.27	47.35	5.61	11.85	0.87

*HRR (Heart Rate at Rest); HR1 (Heart Rate at 1st minute…); bpm^{-1} (beats per minute); ET (Exercise Time).

The parameters of blood analysis and results of ergometry testing are presented in Table 2. The heart rate at rest (HRRest) was in normal range for both groups, but higher in basketball players. Almost in all subsequent minutes of testing the pace of heart was higher in basketball players. The football players achieved longer duration of ergometrical testing, but maximal oxygen consumption was similar. At the beginning of the test (before the treadmill started moving) the mean heart rate was significantly lower in football players, 69.28 ±10.10 vs 73.9 ± 8.75 bpm. During the first 8 subsequent minutes of testing football playeres had lower heart rate than basketball players. The difference was the biggest in 3rd minute of recovery period, 92.03 bpm vs 98 bpm. The duration of test and maximal oxygen consumption showed similar mean values for both sports.

Discussion

In the present study elite basketball and football players of teams in the Macedonian first division were investigated for anthropometric and ergometric parameters. For our knowledge this is the first study in which body composition and results of Bruce protocol were compared for basketball and soccer players in our country.

In this study is observed that height and weight were statistically higher in basketball players, but BMI was almost same in footbal and basketball players. The athletes in both groups showed remarkably developed muscular component, 54.25% vs 53.17%, basketball vs footbal players. The athletes were age ranged between 18 and 30 years, when the major or final part of height is achieved, and bone mass was optimal for adult population, around 17% of body mass. The body fat percent was slightly but statistically lower in basketball players, 13.92 ± 3.97 vs 14.75 ± 1.32.

The mean values of heart rates during the ten minutes of the Bruce ergometry, showed significantly higher values for the first 8 minutes in basketball players. In the 9th and 10th minutes this difference was diminished. In the third minute of recovery period footbal players showed significantly lower heart frequency 92.03 vs 98.0 bpm. Although final results of Bruce testing (exercise duration – ET and $VO2_{max}$) were insignificantly higher in footbal players, the dynamics of heart rate raising during the test and in the recovery period showed better cardiovascular adaptation in soccer players.

Anthropometric variables

The anthropometric features and body mass components are very important parts of whole image of a successful athlete. The anthropometric characteristics and sport specific exercises are in tight positive feedback, affecting both ends of this relationship. It was expected that basketball players will be taller and therefore heavier than footbal players, whilst the BMI was insignificantly different (23.52 vs 23.92). Our athletes showed lesser mean values for height and weight than their colleagues from Kosovo and Serbia (Matkovic et al., 2003).

The task of participants in basketball game is to play with the ball towards the aim, when the finishing movements are above the head. For that purpose it is optimal for basketball players to have extraordinary body height and consequently longer longitudinal extremity's dimensions (Gaurav et al., 2010). The average height of professional basketball players in NBA in 2007 / 2008 years, was 200.6 cm. The average height of the Olympic Games' basketball competitors in Peking 2008 according to the available data was: USA – 199.4 cm, Spain – 199.2 cm, Argentina – 199.6 cm, and Lithuania – 201.7 cm (Bressel e, et al., 2007).

Investigating running economy in elite Belgian soccer and basketball players, Boon and al., reported following anthropometric parameters: height for the soccer at differern playing positions between 180.3 cm for midfileders and 189.3 cm for center back (higher than goal keeper, 187.2cm). Fat component in soccer players was lowest in midfileders 10.2% and highest in goal keeper, 13.2%. Between the Belgian basketball players the highest were players at position center, averagly 206.3cm and the shortest were players at positon guard. The BF% in soccer players were from 10.0 % in guards and 13.8% for players in center (Boon J, 2014,). The male high school basketball players had average weight of 74.59 ±12.02 kg with 11.98 ± 4.3 body fat percent (Ransone, 2016). Analysis of body composition using dual-energy-X-ray absorptiometry in soccer players of English Premiere Ligue showed that non-Caucasian players demonstrated lower BF% (9.2%) than the Caucasian players (10.7%) (Sutton et al., 2009).

In soccer (football) players are predominantly mesomorphic somatotype while basketball players tend to have ecto-mesomorphic body type (Pireva, 2019).The young competitors were more ectomorphic while the professional players were more mesomorphic (Gryko et al., 2018).

Cardio-physiological variables

Required aerobic and anaerobic abilities are different for different teams sports (Sporish et al., 2014). Although team sports are generally characterized as intermittent high-intensity exercises, soccer and basketball players have different physiological profiles. The physiological demands of the basketball game indicates the involvement of glycolysis which lead us to conclusion that the physiological requirements of basketball are mainly on the cardiovascular and metabolic capacities of players (McInnes et al.,).

The analysisi of heart rate of basketball players during the match showed following mean values: in semi-professional players, 172 ± 12 bpm^{-1}, 176 ± 9 bpm^{-1} and 166 ± 15 bpm^{-1} for forwards, midfielders and defenders, respectively; university players (171 ± 13 bpm^{-1}, 173 ± 10 bpm^{-1} and 156 ± 13 bpm^{-1} for forwards, midfielders and defenders, respectively); and recreational players (173 ± 13 bpm^{-1}, 170 ± 12 bpm^{-1} and 162 ± 13 bpm^{-1} for forwards, midfielders and defenders, respectively). Analysis by playing position revealed that midfield and forward players has a greater mean heart rate during a game than defensive players (Araz et al., 1991).

Aerobic energy production contribute for more than 90% of total energy consumptionbut still anaerobic energy production plays an essential role during soccer matches (Bangsbo, 1994). Several publication reported linear relationship between heart rate nad VO_2 in laboratory treadmill test. During the match the average intensity of physical activity is ranged from 70-80% VO_{2max} (Stolen et al., 2005) Primary energy source during the soccer game is aerobic glycolisis, the mean heart rate was around 85 bpm^{-1} and peak heart rates was estimated to be around 98 bpm^{-1} (Saedi et al, 2017). In the study which compared maxymal oxygen consumption in football players and voleyball players, peak values of VO2 max were obtained in football players, and that football as a sport requires higher degree of endurance compared to volleyball (Rankovic et al., 2010).

Our results showed that both groups, basketball and football players had optimal body composition, high muscle mass, avaerage bone mass and low body fat percent. The final results of Bruce test showed same final outcome, maxymal oxygen consumption which was similar for both groups. Although the metabolic demands of football and basketball games are different, the maximal oxygen consumption did not show significant difference. During the most part of ergometrical testing,the two- thirds (8 minutes) consecutive heart rates in footbal players were significantly lower, which could indicate preferable adaptation of cardiovascular system. At the recovery period, in the 3rd minutes after finishing the ergometry testing, footbal players achieved lower heart rate than their basketball colleagues, which is also parameter of good cardiovascular response to effort.

Conclusions:

Basketball and football game combine a variety of individual morphological and physiological traits which in combination with tactical and technical skills result with successful sport performance. Comparison of anthropometric variables showed higher values for height, weight and muscle component in basketball players, while body fat percent was higher in football players. The heart rate's curve during Bruce protocol showed better cardiovascular adaptation in football players, although maximal oxygen consumption was not significantly different.

References:

Alemdaroglu, U., Dundar, U., Koklu, Y., & Asci, A. (2012). Evaluation of aerobic capacity in soccer players: Comparison of field and laboratory tests. *Biology of sport*, 29(2):157-161

American College of Sports Medicine (2000). *ACSM's Guildlines for Exercise Testing and Prescription* (6th ed.). Philadelphia: Lippincott, Williams & Wilkins

Araz, A., & Farraly, M. (1991). Recording soccer players' heart rates during match. *Journal of Sport Sciences*, 9(2):183-189

Balciunas, M., Stonkus, S., Abrantes, C., & Sampaio, J. (2006). Long term effects of different training modalities on power, speed, skill and anaerobic capacity in young male basketball players. *Journal of Sports Science and Medicine*, 5(2):163-70

Bangsbo J. (1994). Energy demands in competitive soccer. *Journal of Sport Sciences*, 12: 5-12

Boone, J., Deprez, D., & Bourgois, J. (2012). Running economy in elite soccer and basketball players: differences among positions on the field. *International Journal of Performance Analysis in Sport*, 14:775-787

Bressel, E., Yonker, J.C., Kras, J., & Heath, E.M. (2007) Comparison of static and dynamic balance in female collegiate soccer, basketball, and gymnastics athletes. Journal of Athletic Training,42(1):42-6

Castagna, C., Chaouachi, A., Rampinini, E., Chamari, K., & Impellizzeri, F. (2009). Aerobic and explosive power performance of elite Italian regional-level basketball players. *Journal of Strength Condition Researche,* 23:1982–1987

Corluka, M., Bjelica, D., Vasiljevic, I., Bubanja, M., Georgiev, G., & Zeljko, I. (2018). Differences in the morphological charactersitics and body composition of footballplayers of HSC Ztinjski Mostar and FC Siroki brijeg in Bosnia and Herzegovina. *Sport Montenegro*, 16(2): 77-81

Drinkwater, E.J., Pyne, D.B. & Mckenna, M.J. (2010). Design and interpretation of anthropometric and fitness testing of basketball players. *Sports Medicine*, 38:565–578

Gaurav, V., Singh, M. & Singh, S. (2010). Anthropometric characteristics,somatotyping and body composition of volleyball and bas-ketball players. *Journal of Physical Education and SportsManagement*, 1(3):28-32

Gryko, K., Kopiczko, A., Mikołajec, K., Stasny, P. & Musalek, M. (2018). Anthropometric Variables and Somatotype of Young and Professional Male Basketball Players. *Sports* , *6*(1):9

Gusic, M., Popovic, S., Molnar, S., Masanovic, B., & Rafakovic, M. (2017). Sport-specific morphology profile: Differences in anthropometric characteristics among elite soccer and handball players. *Sport Montenegro*, 15(1):3-6

Hoffman, J.R. (2003). Physiology of basketball. In: D.B. McKeag (ed). Basketball. Oxford: Blackwell Science, pp. 12–24

Krustrup, P., Mohr, M., Ellingsgaard, H., & Bangsbo, J. (2005), Physical demands during an elite female soccer game: Importance of training status. *Medicine and Science in Sports and Exercise*, 37, 1242-1248

Mancha-Triguero, D., Garcia-Rubio, J., Antunez, A., & Ibanez,S.J. (2020). Physical and Physiological Profiles of Aerobic and Anaerobic Capacities in Young Basketball Players. *International Journal Environment Researches Public Health*, 17(4):1409-1415

Masanovic, B., Vukcevic, A., & Spaic, S. (2018). Sport-Specific Morphology Profile: Differences in Anthropomeric Characteristicsbetween Elite Soccer and Basketball Players. *Journal of Antropology of Sport and Physical Education*, 4:43-47

Matkovic, B., Misigoj – Durakovic, M., Matkovic, B., Jankovic, S., Ruzic, L. & Leko, G. (2003). Morphological differences of elite Croatian soccer players according to the team position. Collegium Anthropologicum, 27(1):167-174

McInnes, S.E., Carlson, J.S., Jones C.J., & McKenna, M.J. (1995). The physiological load imposed on basketball players during competition. *Journal of Sport Scineces*, 13(5):387-397

Narazaki, K., Berg, K., Stergiou, N. & Chen, B. (2009), Physiological demands of competitive basketball. *Scandinavian Journal of Medicine and Science in Sports*, 19, 425-432

Pireva, A. (2019). Anthropometric and Body Composition Differences Among Elite Kosovo Basketball, Handball and Soccer players. *International Journal of Morphology*, 37(3):1067-1071

Popovic, S., Akpinar, S., Jaksic, D., Matic, R., & Bjelica, D. (2013). Comparative study of Anthropometric Measurement of Body Composition betwenn elite Soccer and Basketball Players. *International Journal of Morphology,*31(2):461-467)

Rankovic, G., Mutavdzic, V., Toskic, D., Preljevic, A., Kocic, M., Rankovic, G., & Damjanovic, N. (2010). Aerobic capacity as an indicator in different kinds of sports. *Bosnian Journal of Basic Medical Sciences,* 10(1):44-8

Ransone, J. Physiologic profile of basketball athletes. (2016). *Sports science Exchange*, 28(163):1-4).

Saedi, A., & Khodomaradi, A. (2017). Physical and physiological demand of soccer player based on scientific research. *International Journal of Applied Science in Physical Education*, 1(2):1-12

Sporish, G., Vucetic, V., Milanovic, L., Milanovic, Z., Krespi, M., & Krakan I. (2014). Anaerobic endurance capacity in elite soccer, handball and basketball players. *Croatian Sports Medicine Journal*, 29(2)

Stolen, T., Chamari, K., Castagna, C., & Wisloff, U. (2005). Physiology of soccer. *Sports Medicine*, 35(6):501-36

Stroyer, J., Hansen, L., & Klausen, K. (2004). Physiological profile and activity pattern of young soccer players during match play. *Medicine and Science in Sports and Exercise*, 36(1):168-74.

Sutton, L., Scott, M., Wallace, J., & Reilly, T. (2009). Body composition of English Premier Legue soccer players: influence of playing position, international status and ethnicity. *Journal of Sports Sciences*, 27(10): 1019-1026